

AFIT/GMO/LAL/99Y-10

THE AVAILABILITY OF CONTAINER SHIPPING  
NEEDED TO MEET WARTIME AMMUNITION  
SUSTAINMENT REQUIREMENTS

GRADUATE RESEARCH PAPER  
Paul R. Murphy, Major, USAF  
AFIT/GMO/LAL/99Y-10

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GRADUATE RESEARCH PAPER

Presented to the Faculty of the Graduate School of Logistics  
And Acquisition Management of the Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the  
Degree of Master of Mobility Studies

Paul R. Murphy, B.S., M.S.

Major, USAF

June 1999

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### **Acknowledgments**

I wish to thank my senior sponsor Major General Charles H. Coolidge, Director, U.S. Transportation Command TCJ3/J4, for his backing of this project, and the help his backing made available. Special thanks to Col Dennis Kaan, USTRANSCOM TCJ3-OD, under whose mentorship and guidance I got this project off the ground. Also thanks to Commander Lou Walker, USTRANSCOM TCJ4-LTI, for her invaluable guidance and patience.

Thanks to the AFIT faculty, especially Dr. David Vaughan, the Assistant Dean, and my advisor Dr. William A. Cunningham, whose insights into both the civilian and defense way of doing business were invaluable. He is the Professor, Logistics Management, Wright-Patterson AFB, Ohio.

I am indebted to the Air Mobility Warfare Center Research Librarian, Ms Janice F. Missildine, for her monumental kindness and phenomenal research assistance. Supreme thanks to my wife, Denise, and my three children: MaryCatherine, Paul, and Tim for the time this project took away from them.

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**Abstract**

The paper examines current military and commercial sealift infrastructure to explore its ability to provide for all stated DoD ammunition sustainment requirements. A background overview of U.S. strategic sealift summarizes the evolution of our current sealift infrastructure. Subsequent chapters deal with individual research questions.

The container has revolutionized the shipping industry but it places unique limitations on the movement of ammunition aboard ships. The physical determination of which ships get used depends on the time and unique constraints of each individual ammunition movement. The impact of the growing size of containerships and the resulting throughput limitations that this size places on the three CONUS ammunition ports are examined. Bigger is not necessarily better for shipment of ammunition.

The paper addresses current and short-term capabilities versus stated requirements in an attempt to identify potential shortfalls. The paper also explores the difference between MRS BURU and actual operational planning requirements for wartime ammunition. It finds a disparity between the numbers due to the fact that MRS BURU requirements drive DoD funding, while current operational plans deal with the transportation feasibility of actual shipping capacity.

# THE AVAILABILITY OF CONTAINER SHIPPING NEEDED TO MEET WARTIME AMMUNITION SUSTAINMENT REQUIREMENTS

## **I. Introduction**

The United States military is increasingly reliant on rapid global mobility to project power. Therefore, the capability to rapidly move wartime stocks to forward locations has become a linchpin of that capability. With its overseas drawdown, the Army in particular relies heavily on follow-up ammunition sustainment capability that can only be efficiently transported by sealift. Historically, virtually all of the U.S. war-fighter's sustainment ammunition has been transported by breakbulk cargo ships. In 1999 these ships are being phased out of the commercial inventory in favor of larger container vessels. As the U.S. military increases its intermodal capability, a potential sealift shortfall exists due to the unavailability of suitably sized and configured containerships combined with the growth in individual ship size of the containerized merchant fleet. This research paper addresses current and short-term capabilities versus stated requirements in an attempt to identify any potential shortfalls. The topic is worthy of study due to our current defense drawdown coupled with the requirement to fight two near-simultaneous theater wars.

## **Problem Description**

U.S. Transportation Command (USTRANSCOM) must fulfill stated Department of Defense (DoD) requirements for ammunition movement during any major contingency

deployment. The problem revolves around the availability of merchant shipping, whether U.S. flagged, owned, controlled, or contracted, which is of the proper size, type and availability needed to meet wartime ammunition sustainment requirements.

The limitations of available of ocean shipping of the correct size and capability must be understood by logistics planners and USTRANSCOM in order to make efficient decisions on ammunition movement and method of shipping. Flow must be planned accurately from fort to port, at the dock area (not to exceed maximum allowable explosive tonnage at dock location while loading), and from port to forward operating theater. The Army currently relies on Military Sealift Command (MSC) to carry its ammunition from port to theater. The current planned DoD wartime ammunition sustainment requirements are very large. Ammunition itself is a unique and dangerous cargo that is currently limited to loading and unloading at three continental U.S. (CONUS) locations: Weapon Support Facility (WSF) Seal Beach, Detachment Port Hadlock, WA; Military Ocean Terminal (MOTSU), Sunny Point, NC; and WSF Seal Beach, Detachment Concord, CA. This limiting factor is compounded by the size, configuration, and current worldwide geographical position of commercial vessels at the start of a perspective contingency. The template for a major contingency ammunition movement remains Desert Shield/Storm. However, U.S. commercial fleet and standard container technologies have changed since 1990. These factors must be taken into account when assessing true near-term capacity.

## **Research Questions**

My graduate research paper will break down the problem by focusing on the following five research questions:

1. What is the impact of the growth in containership size?
2. How has the Army's ammunition containerization effort affected shipping?
3. What throughput limitations exist at the three DoD strategic ammunition port facilities as a result of the rise of containerships?
4. By what process does Military Sealift Command actually fill the requirement for ammunition sustainment sealift?
5. How accurate are the Mobility Requirement Study-Bottom Up Review (MRS BURU) requirements for ammunition to support likely scenarios for both one and two near-simultaneous theater wars?

## **Graduate Research Paper Overview**

This paper explores the factors that affect the availability of container shipping needed to meet wartime ammunition sustainment requirements. It begins with a background overview of U.S. strategic sealift explaining how the current DoD and commercial sealift infrastructure reached its current state. The next chapters, III through IV, address in sequence the five research questions stated above.

## **II. Background**

### **U.S. Sealift from WWI to Desert Storm**

As the United States has at present no aggressive purposes, its merchant service has disappeared...because a peaceful, gain-loving nation is not far-sighted, and far-sightedness is needed for adequate preparation, especially these days.

-Alfred Thayer Mahan, 1889 (22:31)

Mahan was concerned about the demise of the U.S. Merchant Marine in the late 19<sup>th</sup> Century. In his famous work *The Influence of Sea Power upon History*, he voices concern at a time when the American Economy was booming, and yet most goods and agriculture produced by the nation was carried on foreign merchant ships. This concern rings true at the end of the 20<sup>th</sup> Century. Sealift capacity is a U.S. national asset. It provides the majority of lift support for wartime deployment, reinforcement, and sustainment operations. Historically, sealift has accounted for 90-95% of the total cargo delivered over their duration (11).

Despite America's rise to military and economic superpower status during the 20<sup>th</sup> Century, the U.S. owned and flagged fleet has steadily declined. Moreover, it has done so at a time of explosive growth in world trade. This is troubling because filling wartime military sealift requirements has always depended on private sector capacity.

The relative small size of the U.S. Merchant Marine at the beginning of World War I left the U.S. dependent on the British merchant fleet to get almost all of the "Arsenal of Democracy's" war material to the fight. It was under the protective umbrella of Pax Britannica that America grew to industrial prominence. The U.S., in traditional isolation, was not prepared to fight European sized enemy armies at inter-continental

distances. Upon America's late entry into the war in 1917, a massive multibillion-dollar buildup in shipping was implemented. However, due to the lead-time involved in shipbuilding, the war was virtually over by the time most of these new vessels were ready for use.

Following the war, in an attempt to retain some of this capability, the U.S. set a policy of maintaining a reserve of merchant ships under the authority of the U.S. Shipping Board. By the end of 1922, this fleet peaked at 1,207 ships. Then, over the next 15 years, 750 of these ships were sold or scrapped (24:1). In 1936 the Merchant Marine Act established the Maritime Commission which took over what remained of this "mothball fleet." The Act also established the right of the U.S. government to requisition ships and to adopt as naval auxiliaries any commercial vessels that had been built with government subsidies (38:23).

At the time of Pearl Harbor, the principal logistical mission of the Navy, as defined in joint Army-Navy plans, was "to provide sea transportation for the initial movement and continued support of Army and Navy forces overseas; to man and operate [sealift ships]" (3:21). But at the outbreak of World War II the Navy was wholly unprepared to assume its assigned logistical mission. Most Navy-owned cargo vessels were pre-assigned as replenishment ships that sailed with the fleet. The Naval Transportation Service was a small, under-staffed, and highly subordinate agency, existing almost entirely on paper. It had no clear concept of its own mission. Worse, no channels or procedures existed between the services by which Army plans for overseas movements could be efficiently translated into terms of naval shipping requirements

(3:66). It proved to be a long and painful process to set up a true working joint Army-Navy system (38:22).

At the beginning of World War II it once again fell to the British merchant fleet to provide most of the shipping the U.S. required while the country tooled up its economy for another full-scale war. This time however, the British were extended all over the world. In the first four years of the war German U-boats and other anti-shipping forces nearly strangled Britain into starvation. Merchant shipping became the super-critical Achilles heel of the Western Allies. As in the First World War American industry quickly went into high gear to fill the gap. America produced a record setting 5,500 merchant vessels between 1942-45 (most of these were the famous *Liberty Ships*). Thus, the lesson of being caught short of suitable numbers of vital merchantmen at the outbreak of war was repeated.

Once again, following a major war, the U.S. sold most to the highest bidder while preserving some of this capacity for use in time of emergency. The Merchant Ship Sales Act of 1946 established the National Defense Reserve Fleet (NDRF). It essentially consisted of approximately 1,900 of the 5,000 leftover ships that were not sold to private firms. In 1950 the Maritime Administration (MARAD) assumed responsibility of the NDRF and established eight CONUS anchorages for it.

In 1949 the U.S. Secretary of Defense issued a directive making the Secretary of the Navy the single manager for ocean transportation. Military Sea Transportation Service – renamed Military Sealift Command (MSC) in 1970 – was established the same year.

Over the next 30 years this renewed mothball fleet proved itself an invaluable national asset. During the Korean War MARAD broke out 720 NDRF ships to support both operations in Korea and to overcome a severe shortfall of shipping on both the Atlantic and Indian Ocean trade routes. During the 1956 Suez Crisis 257 ships were activated to lessen the strain on international shipping caused by the closure of the Suez Canal. This action expanded lift capacity and helped reduce shipping rates worldwide. From 1965-72 some 172 NDRF ships were broken out to support operations in Vietnam. These ships accounted for fully one-third of the dry cargo required (24:2-11).

By the 1970s the NDRF was becoming obsolete. In response to a General Accounting Office report questioning its real military utility, the U.S. established a Ready Reserve Fleet (RRF) for MSC usage. The initial cadre of RRF ships was drawn from the best of the NDRF. For the first time the Navy recognized the need to include militarily useful container ships. Additionally, a subsequent DoD study of requirements covering the period from 1985 onwards proposed the pre-positioning of ships in strategic locations worldwide. This was done in order to establish "at a minimum, sufficient shipping capacity under U.S. government control and/or in the U.S. flag commercial fleet to meet surge and sustainment requirements of that portion of a global war wherein allied shipping is not available" (38:32). The U.S. had officially recognized that a conflict would have to be fought with sealift vessels built in peacetime. In 1988 MSC's common user sealift assets were placed under the combatant command of U.S. Transportation Command (USTRANSCOM).

In 1989 President Bush signed the National Security Directive on Sealift. This document recognized that sealift was essential both to executing U.S. forward defense



strategy and to maintaining a wartime economy. It stated that "the nation's national sealift objective was to ensure that sufficient military and civil maritime resources would be available to meet both defense deployment and essential economic requirements in support of our national security strategy." The directives major points included:

1. The nation would rely on the U.S.-owned commercial ocean carrier industry "to the extent it is capable," to provide sealift in peace, crisis, and war.
2. The U.S. must be prepared to respond to security threats unilaterally.
3. The DoD would determine the requirements for sealift.
4. The Department of Transportation (DoT) would determine the capacity of the maritime industry to meet DoD sealift requirements via its subordinate: MARAD.
5. DoD and DoT would promote the incorporation of National Defense features in new built and existing ships.
6. During peacetime, federal agencies would promote, through laws and regulations, the readiness of the U.S. Merchant Marine and supporting industries to respond to critical national security requirements.

The directive called for the expansion of the RRF, the conversion of container ships to handle Army equipment, the procurement of crane ships, hospital ships, and the acquisition of pre-positioned aviation support and supply ships for the Air Force and Marines (24:8). Above all it was considered of vital interest that the economy not suffer dislocation as a result of the draw caused by wartime shipping requirements.

#### **U.S. Strategic Sealift in Desert Shield/Storm**

The Persian Gulf War is extremely important because it stands as the principle benchmark used for current strategic sealift planning. Although this research paper is primarily concerned with sustainment sealift, it is instructive to get a snapshot of how

afloat pre-positioned and surge sealift was employed in this last real-world contingency. Due to the success of the operation, it has become our global mobility frame of reference.

It must be understood that in Desert Storm sealift operations enjoyed unique advantages. First, there was no serious threat of enemy action against our sea lines of communication. Ships entered the area of operations (AOR) unhampered throughout the operation. Hence there was no combat attrition. Second, although it became a bottleneck, the Suez Canal remained open throughout the operation. Third, there was no near simultaneous MTW to deal with. And finally, the AOR offered excellent port facilities thanks to farsighted Saudi investment in port infrastructure (25:18).

On 7 Aug 1990, the day of the decision to execute Desert Shield, the first of 25 ships of the Afloat Pre-positioning Force (APF) were ordered to get underway. These pre-loaded and fully manned ships were strategically located at Diego Garcia and Saipan. 13 were Maritime Pre-positioning Ships equipped to support Marine Expeditionary Forces. The remaining 12 were loaded with Army and Air Force heavy equipment and sustainment supplies (including ammunition). By 15 August the first two ships arrived at Al Jubayl, Saudi Arabia. This was the vanguard of a vast armada to follow in sequence. All the Diego Garcia based "prepo" ships were unloaded by the end of September. Ships from Saipan in the Pacific took longer closing their initial missions on 13 December. Once they had offloaded their pre-positioned cargoes seven of the ships were sent back to the U.S. for re-use. The remainder stayed in the AOR as floating ammunition and fuel platforms. The combined APF accounted for 19% of total DESERT SHIELD/STORM cargo (25:118).

Next to sail, following their allotted four-day notification, were the eight CONUS based Fast Sealift Ships (FSS). Equipped with ramps and cranes, the FSS were quickly loaded (primarily with wheeled combat vehicles) and dispatched. They began arriving in the AOR on the heels of the APF. Measuring 946 feet long, each FSS carries about 1000 pieces of equipment or the equivalent of over 200 C-5 heavy-lift cargo aircraft. Capable of 33 knots, they averaged only 23 knots enroute to the AOR due to weather and the Suez Canal bottleneck. With one FSS broken down enroute, the remaining seven closed their first voyage by 7 September. Due to excellent port infrastructure the first ship was offloaded in a record 12 hours. The second was unloaded the following day in under eight. Thanks to their speed, five FSS managed three round-trip deliveries to the AOR, a record for all shipping involved in DESERT STORM. Together the FSSs accounted for 13% of total cargo tonnage for the operation (25:120).

While the FSS were being put in motion, TRANSCOM asked MARAD to start activating ships of Ready Reserve Fleet that at the time totaled 96 of the most modern "militarily useful" ships. Overall only 72 of the 96 were activated. Depending on their status these ships were supposed to be made ready for sea in 5, 10, or 20 days. In practice only 20 of the RRF ships were activated inside the required time limits. Severe mechanical problems, especially with the older steam propulsion systems, were the main reasons. MARAD explained the sub-standard performance on lack of peacetime maintenance funding. The most desirable RRF ships, generally the RO/RO, Roll-on/Roll-off ships, were activated ahead of the smaller break-bulk ships that were required for ammunition. These larger ships averaged 110,000 square feet of space verses only

40,000 for the latter. They could be offloaded twice as fast. By the end of operations the RRF had accounted for 28% of total unit cargo shipped (25:121).

One statistic of interest, MSC estimated in its after actions reports that it cost an average of \$1.8 million to activate and \$3.9 million to deactivate each RRF ship. This is due to a MARAD and DoD policy of returning RRF ships to the reserve status in better shape than they had been prior to breakout (25:121).

The remainder of the NDRF, the mothballed fleet of 116 vintage WWII ships, was not used for the operation. Multiple reasons included 30 to 90 day breakout times; relative small size; larger crew requirements; obsolescent (steam) propulsion systems; and slower loading and transit times (25:121).

Together the APF, FSS, and RRF were able to handle 60% of required Desert Storm tonnage. Chartered commercial ships, both U.S. and foreign flagged, made up the remaining 40%. MSC chartered commercial ships through the release of a worldwide Request for Proposal (RFP). In this way, MSC found a total of 32 U.S.-flag vessels. When U.S. merchant ship availability through RFP was exhausted MSC then turned to allied and friendly-nations. On 18 September, the first foreign (Canadian) chartered ship, arrived in Ad Damman, Saudi Arabia. Throughout the operation MSC obtained the use of 177 vessels from 34 nations. The most prominent flags included Cyprus (28), Norway (21), Panama (21), Greece (17), and the Bahamas (13). The former Eastern Bloc nations of Poland and Rumania contributed five and three respectively (6:123). The Soviet Union declined repeated requests by MSC, explaining that help would be "inappropriate." Japan, with a merchant fleet of over 2,500 ships offered only financial assistance.

Foreign vessels accounted for 26% of total sealift required. Commercial U.S.-flagged vessels accounted for only 13%. For strictly dry cargo (unit equipment plus containerized and breakbulk supplies), the combined commercial and military U.S. flag fleet carried 79% while foreign flags carried the remaining 21% (6:123). It should be noted that there was sharp competition between the coalition partner nations for available sealift capacity throughout the operation.

In total, MSC chartered 206 ships to handle the surge requirements of military material and ammunition to the AOR from European and CONUS ports. Because of the Cargo Preference Act, MSC ordinarily charts only U.S.-flag vessels to satisfy requirements. However, because of limited availability, foreign-flagged ships carried 19% of the ammunition shipped from the U.S. and over 90% of that from European depots. Even with adequate shipping available, the movement of munitions was the slowest of all classes of supply. This fact was not helped when the initial theater requirement for 30 days of supply (DOS) was increased to 60 DOS. In the final analysis most of the ammunition stocks on hand in time for the actual fighting came from the initial surge APF (4).

If voluntary shipping had not been available on the open market, MSC could have called on commercial ships from the Sealift Readiness Program (SRP). Administered by MSC, the SRP program required shipping companies with MSC contracts or with government subsidies to commit 50% of their cargo capacity to MSC for possible use during less-than-full mobilization, contingencies, and national emergencies. To activate the SRP (since superseded by the Voluntary Intermodal Sealift Agreement (VISA), MSC would have been required to show that NDRF ships were not available in sufficient

numbers to meet requirements. And, additionally, that there was an insufficient pool of commercial shipping capability available at "fair and reasonable" prices to meet requirements. This call-up would have seriously disrupted normal trade operations. However, because adequate voluntary commercial shipping could be found on the open market, it was unnecessary.

In summary, the experience of strategic sealift operations in Desert Storm exists as the principle example for future large-scale contingencies. Sealift operations enjoyed several fortunate advantages that cannot be counted on in the future. With the U.S. Merchant Marine on a continued down-slope in numbers, the U.S. might be hard pressed in the future to find enough available shipping on the world market to meet requirements.

#### **Current Sealift Infrastructure**

MSC, headquartered in Washington DC, assumes responsibility for providing sealift and ocean transportation for all DoD and government agencies. Today the command operates more than 130 ships and several shore offices around the world. It employs approximately 7,500 people worldwide, the vast majority of whom are assigned to seagoing jobs. 4,700 of these are federal civil servants; another 1,100 are military; and 1,700 are MSC contractors (30).

MSC ships, unlike other U.S. Navy ships, are crewed by civilian merchant mariners. Some MSC ships also have small military detachments aboard to carry out specialized military functions such as classified communications and cargo coordination. In wartime, the number of contractor-employed mariners can expand to double the peacetime number, and MSC is empowered to add up to 1,500 naval reservists.

MSC's worldwide operations are financed through the Transportation Working Capital Fund (TWCF). This is a revolving fund that provides working capital for MSC operations. MSC receives funding for operations from TWCF and, in turn, charges its government customers for the sealift services provided to them. Payments from government agencies using MSC services go back into TWCF. It is designed to break even, not make a profit. However, when MSC can provide sealift at a cost less than the charged rate, they can use the savings for improvements. MSC spends about \$2 billion in TWCF funds annually (2).

Since the Gulf War the U.S. military has steadily drawn down its overseas forces and has become increasingly reliant on strategic sealift to transport its CONUS based forces and material to meet theater threats. Today theater OPLANs make the assumption that the required lift will be available even if two near simultaneous MTWs occur. However, in the last decade, some notable changes to the commercial infrastructure have occurred (11).

Today strategic sealift forces can be divided into the same three broad categories of: afloat pre-positioning, initial surge, and sustainment that existed during the Gulf War. But a great deal of the commercially useful sealift capability that existed has been trimmed out through modernization and restructuring. Over 90% of the shipments to the Persian Gulf went breakbulk. Those ships are becoming increasingly scarce. The majority of commercial dry cargo vessels are now containerships. These ships are getting larger and commercially more efficient by the year. But larger is not necessarily better in qualifying a ship as "militarily useful" (35). The absolute size of the U.S.-flag international fleet has declined in recent years. However, its commercial productivity has

improved substantially. In 1995, the U.S.-flag international liner fleet carried over 42% more cargo than in 1970, but in far fewer-but larger-vessels. The average capacity of liner vessels in the U.S.-flag fleet today is nearly 28,000 deadweight tons (DWT), compared to 12,000 DWT in 1970. The average crew size of 35 in 1970 has been reduced by newer technology to a containership average of 21 (14:19). Like other segments of the private marketplace, the commercial transportation industry continues to downsize, streamline and eliminate less efficient (usually smaller) vessels.

Reduced numbers of commercial assets (vessels), competing military and commercial priorities, and commercial market disruption during contingencies must be factored into the total strategic sealift equation (35). To ensure continued availability of this critical capability the Maritime Security Program, funded by MARAD, was started in 1996 to further national economic security objectives. Similar to the SRP, it is designed to ensure the U.S. will continue to have a fleet of commercial cargo vessels available in time of war. Under MSP the government contracts with owners of U.S.-flag commercial ships for service when needed to cope with national emergencies. These U.S.-flag merchant ships are owned by U.S. citizens and crewed by American merchant mariners (23). There are 47 vessels currently enrolled. Table 1 breaks these ships down by participating company and the number of ships committed.

As a condition for receiving government financial support MSP participants are required to enroll their vessel capacity and intermodal resources in the Voluntary Intermodal Sealift Agreement (VISA) program. Approved by Defense Secretary Cohen in 1997, VISA is MARAD's national emergency preparedness program. VISA provides DoD access to U.S. owned ships and the worldwide intermodal system that supports



**Table 1. Current MSP Participants (23):**

American Ship Management	9 vessels
Central Gulf Lines	3 vessels
Waterman Steamship	4 vessels
Crowley Maritime	3 vessels
First American Bulk Carriers	2 vessels
Farrell Lines	3 vessels
FOBC I, -II, -III	3 vessels
Maersk Line	4 vessels
OSG Car Carriers	1 vessel
<u>Sea-Land Service</u>	<u>15 vessels</u>
 Total	 47 vessels

them. The program consists of three stages that incrementally increase the carriers' contribution if required (30). Under this system the DoD first solicits companies on a voluntary basis. After all volunteers are exhausted, the companies have agreed to participate as follows:

**Stage I:** 15% of the U.S. participants. Activated by CINCTRANS with approval of SECDEF. MARAD is notified to execute the activation.

**Stage II:** 40% of the U.S. participants. Activated by CINCTRANS with approval of SECDEF. MARAD is notified to execute the activation.

**Stage III:** 100% of MSP vessels. Activated by CINCTRANS with approval of SECDEF. MARAD allocates available capacity to meet the requirements.

CINCTRANS also activates (50% of non-MSP vessels).

The system is designed to make requisitioning vessels a last resort after all other measures fail to meet requirements. All known transportation requirements for a single

regional conflict will be covered by Stages I and II (10). Commercial operators can volunteer capacity in VISA Stages I and II, but in Stage III participants must commit at least 50% of their capacities for non-MSP vessels and 100% of their capacities for MSP enrolled vessels.

To participate in the program, shippers must be signed up to VISA Stage III, which is 50% of his U.S.-flag fleet. In exchange VISA participants receive priority for award of DoD peacetime cargo contracts. Additionally, if a carrier is receiving a MARAD (ensured capacity) subsidy such as that provided by Maritime Security Act, carriers must commit 100% of the vessel capacity for ships receiving that subsidy (26).

The keystone of VISA is that it brings U.S. commercial carriers into the DoD planning process for the first time. This enables carriers both to better meet defense transportation needs and to plan options for their own commercial operations during contingencies. Anti-trust provisions have been arranged to allow carriers to plan in peacetime how they will operate together when activated (26). To eliminate unknowns, contracts for vessels are pre-negotiated. Previously, commercial shipping agencies were not given information on the quantities or types of defense cargo slated for movement. Therefore, the transportation companies can now be considered an integral part of the military contingency planning process (30).

VISA and MSP are complimentary programs. More than 80% of U.S.-flag commercial shipping capacity is enrolled in VISA Stage III. Approximately 110,000 TEUs or 10 million square feet of militarily useful capacity is available from MSP participants (40). In this manner, the government leverages a relatively small investment to provide a large commercial transportation network for its use in national emergencies.

Thus DoD will have access by agreement to most U.S.-flagged shipping.

However, U.S. owned or controlled shipping does not fall under this category. This type of shipping has historically been at the disposal of DoD but it cannot be called-up even in times of national emergency. A December, 1988 federal court of appeals ruling stated that the "U.S. government does not have the authority to press U.S.-owned foreign-flag ships into service" (12).

The trend toward fewer yet larger ships poses a problem in terms of true ammunition capable capacity. VISA differs from SRP in that it transitions from a vessel-oriented program to a capacity oriented program. For example, under VISA there is now a 167K TEU capacity whereas under SRP there was only a 103K TEU capacity. But TEU capacity alone might be misleading. Under VISA two very useful 1,500 TEU ships can be withdrawn and replaced by a single 3,000 TEU ship that cannot necessarily access an ammunition port. In fact of the 47 VISA participants only 36 are container ships. Of these 21 are over 3,000 TEU vessels (40). Therefore the true number of ammunition "useful" U.S.-flag containerships is only 15.

### **III. Mega-Ship Trend**

**How does the upward trend in the size of commercial ships impact the movement of sustainment ammunition?**

Since the beginning of ocean borne commerce dry cargo had been loaded and shipped in the same basic way. Sea-Land Corporation changed all that in 1956 by pioneering the concept of containerization and with it the inter-modal revolution that followed. Today container vessels dominate the world's trade lanes leaving the few remaining breakbulk cargo vessels an endangered species (29:10).

At the beginning of the container revolution the twenty-foot container was the commercial industry standard. To this day, container ships are described in terms of Twenty-foot Equivalent Units (TEU). The twenty foot container is also the standard size used by the DoD to ship its' ammunition. However, the international industry standard has advanced to the larger, more commercially efficient 40-foot size. This is a problem because DoD ammunition, due to its heavy weight, cannot be shipped in this larger size. When 20-foot containers are loaded aboard ship end to end in a 40-foot cell that has not been reinforced; the pressure where the two containers meet would damage the deck. A container must sit within a shipboard cell that is configured for either 20 foot or 40 foot containers. But, currently, the clear preponderance of shipboard cells are configured for 40-foot size.

Only 23% of U.S. container capacity can accommodate 20-foot containers. This potential shortfall of adequately configured ships can be transparent because ship capacity is still stated in TEU, and does not discriminate between 20-foot cells and 40-foot cells. The last MARAD examination of total 20-foot capacity in the U.S.-flagged

fleet was done in 1996. At that time total existing (not to be confused with available) capacity was two times larger than DoD requirements.

With newer ships configured to handle primarily the 40-foot and not the 20-foot container, the pool of available shipping that can handle this category is clearly on the decline. Or is it? A notable improvement to gain access to ships only capable of carrying 40-foot containers was initiated in 1996. It was the use of adapter frames that fit inside a 40-foot cell allowing it to hold two 20-foot containers. With adapters installed virtually any containership can carry ammunition containers. This development may be the solution to bridge the gap between DoD and industry standards. It will only be true if enough of the currently scarce adapters are procured (28).

What is the best size ship for transporting ammunition? MRS BURU describes a "notional" ammunition capable containership as being 1,500 TEU. This size was chosen partly due to the physical limitations of the three CONUS ammunition ports that will be discussed in detail in chapter V. However, the current world average is 2,200 TEU and is climbing yearly. Most of the ships brought into service over the last year are 4,000 TEU. There are ships on the drawing board (and currently coming into service) that will handle 6,000 TEU. All these newer, larger ships are referred to in the trade as "Mega-Ships." OOCL of Japan, for example, is building eight 4,960 TEU ships. These behemoths are purpose built to carry huge quantities of cargo between major specialized ports such as Hong Kong and Seattle. But it is their very size that denies them access to all but the largest ports. Unfortunately this trend is expected to continue beyond the foreseeable future (18).

U.S.-flagged containerships range in size from 1,027 to 4,832 TEU. The average is roughly 2,400 TEU. In total there are 89 containerships of all sizes in the U.S.-flagged fleet. This includes all 47 VISA participating vessels. Often overlooked are at least 15 Jones Act ships that ply the American inland waterways. Many of these ships are ammunition capable and all are by law U.S. owned, crewed and flagged. According to MARAD it is an untapped source of ships that are ideal size for ammunition shipment (27).

To get a rough idea of typical distribution Table 2 shows a 1998 two-week snapshot broken down by coast. For example, during this timeframe there were 16 U.S. flagged containerships somewhere on the East Coast that could be pressed into service if needed.

**Table 2. Typical U.S. Flagged Containership Availability (28)**

East Coast	16 Ships	44,000 TEU
Gulf Coast	4 Ships	5,500 TEU
West Coast	<u>7 Ships</u>	<u>15,200 TEU</u>
	27 Ships	64,700 TEU

In the worldwide container fleet there are approximately 1,500 ships that are 2,000 TEU or less. As Figure 1 shows, more than half of this fleet operates on major trade routes. The majority of this shipping operates on routes to and from Asia and the Pacific Rim. Most of this foreign-flagged shipping is not U.S. owned or controlled. With 40% of all wartime shipments expected to be shipped under foreign flag, the reliance on foreign shipping capacity is an unwelcome but necessary assumption made by U.S. planners (16). Moreover, due to economic and seasonal forces beyond any nation's

control, exactly where the smaller, more militarily useful containerships will be at the start of an un-anticipated MTW is an impossible question to answer.

In actuality, most of the smaller container ships in the world are not close to the CONUS at all. Rather they are found on the feeder trades of the Pacific Rim and

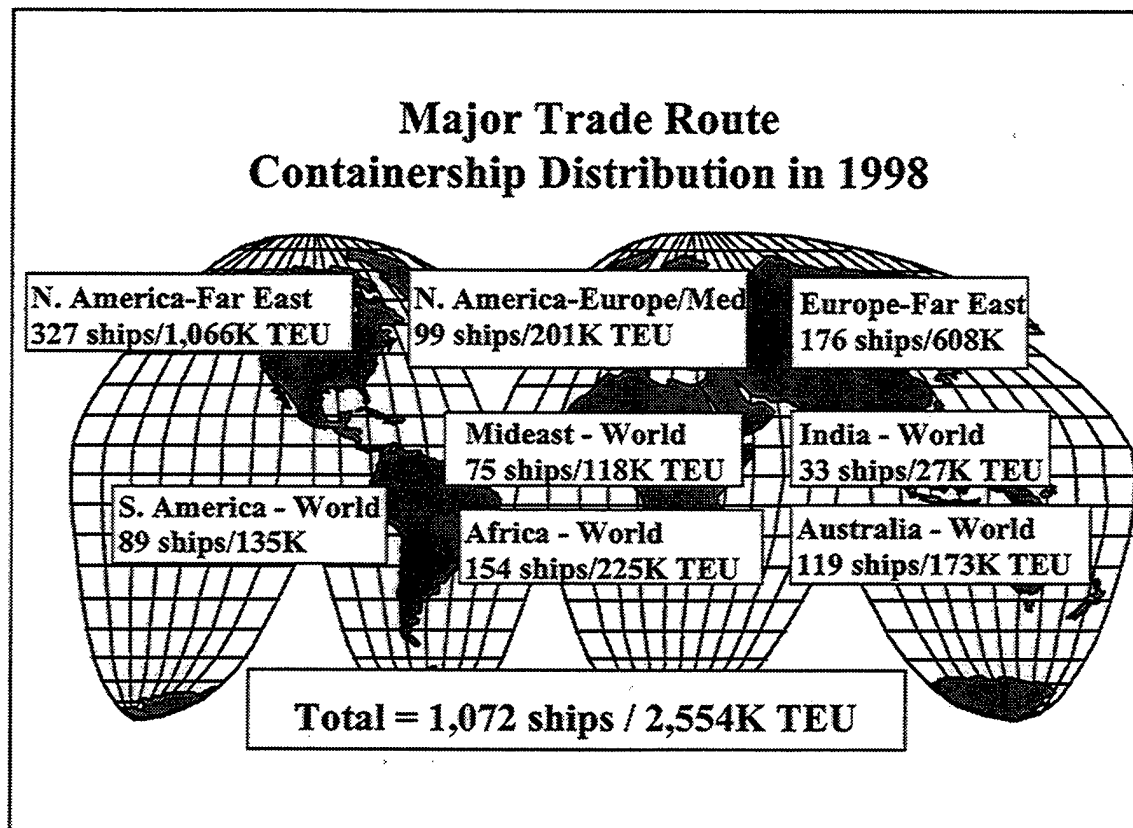


Figure 1. Major Trade Route Containership Distribution in 1998 (28)

elsewhere. Typically these smaller ships operate from less commercially viable foreign ports carrying various dry cargoes to larger ports such as Yokohama and Hong Kong.

Containers are then transferred to the larger mega-ships which are more lucrative for transoceanic shipment. The larger shipping companies, both U.S. and foreign owned,

have sharing agreements with feeder ship operators. U.S. companies like Sea-Land and APL for example, make heavy use of this arrangement (13:n.pag.).

To help maintain U.S.-flagged capacity the DoD subsidizes U.S. shippers in peacetime under VISA in return for assured TEU capacity in time of war. But Sea-Land and APL, the two largest VISA participants, don't own these types. To provide militarily useful containerhips they must specially charter smaller types of vessels from the world market. This is difficult to do. The ships must be obtained from smaller liner service carriers who are primarily interested in holding onto their regular business. The availability of these ships varies widely. Assuming they can be contracted away from their normal liner service, they typically need more than a week for transoceanic travel time (16). Owned and flagged by various countries, there is never certainty of support for U.S. foreign policy objectives by the countries of ownership. During Desert Storm these smaller, foreign-flagged carriers exhibited an aversion to put their assets in harm's way. For all these reasons critics argue that we pay U.S. shipping companies a peacetime subsidy for ships they don't have and might not be able to obtain in times of national emergency (13).

The fact is companies have had trouble finding appropriate shipping during peacetime exercises as well. During exercise TURBO CADS 95 Sea-Land had a requirement (given six months in advance) for a 1,200 TEU ship. They couldn't produce one. And even if available, the "notional" 1,500 TEU vessel can only be loaded with about 500 containers in many cases. In one exercise the 2,758 TEU capacity Sea-Land *Innovator* was used to fill a requirement for 700 TEU. But the ship only has 300 TEU in



20 foot cells so the ship was forced to sail with only 300 twenty-foot containers aboard, leaving over 400 behind at the port (7).

As mentioned in the previous chapter, VISA participating companies are signed up to provide TEU capacity not necessarily "militarily useful" individual ships. This means that older and smaller ships termed "notional" by MRS BURU are being replaced by huge containerships that are incapable of making ammo ports. Additionally, under VISA, a company can replace any older U.S. flag vessel with a newer (and usually larger TEU) vessel without MARAD approval (15:8).

### **Conclusion**

Many problems are in the eye of the beholder. With the foreseeable trend in ship size only climbing, the MRS BURU assumption of a notional container ship as 1,500 TEU may not be realistic. The newer the ship, the less 20 foot capacity it probably has. The good news is the use of adapter frames should make any containership useful, at least to some extent, for carrying ammunition. The bad news is that the size of the ship itself, not its configuration, might be the biggest limiting factor preventing it from being usable.

#### **IV. Containerization**

##### **How has the Army's ammunition containerization effort affected shipping?**

The container revolution brought several advantages to shipping including the security of the cargo, rapid transfer between modes of transportation (intermodal capability), and the ability to optimize cargo holds and deck space. The ability to maximize cargo space aboard ship is especially critical in time of war when the risk of being sunk is run every time a ship sails. The benefit of maximizing cargo space was illustrated in World War II by the use of boxes for vehicles. This was done not for intermodal reasons but rather for cargo space. Vehicles took up large amounts of floor space when loaded aboard ships in parking lot style. By boxing and stacking just 15% of the vehicles headed for Europe an estimated 80,000 tons of capacity per month was saved (38:25).

Today, most commercial dry cargo is containerized. It is packed or "stuffed" in ISO containers at the warehouse or plant. These containers are hauled by rail or by truck to the seaport of embarkation (SPOE) where they are loaded by shore crane onto container ships configured with cells into which the containers may be stacked. The process is reversed from the seaport of debarkation (SPOD) to the final field destination where the containers are "stripped." Containerized ammunition is moved in the same fashion except that as explosive material it requires special care (32:9).

##### **Container Loading Limitations**

The DoD standard for containerized ammunition is the 20-foot long by 8.5 feet high International Standards Organization (ISO) container. Each loaded container

weighs about 13 tons on average (depending on the cube and weight ratio). The NEW of each container is dependent upon the specific ammunition loaded into the container. Care must be taken to separate cargoes that are an explosive hazard when stowed together. Inside the container itself ammunition is secured by wooden blocking and bracing to prevent it from moving inside (39:8). This protective bracing within the container eliminates the need for protective sheathing, usually a layering of wood, that must be added to line the hold of a breakbulk ship to prevent shifting and sparking caused by the metal casings shifting on the metal decks/bulkheads.

Ammunition cargo is not homogenous. It is divided into stowage categories determined by the U.S. Coast Guard's Code of Federal Regulation (CFR) and the International Maritime Dangerous Goods (IMDG) Code. Internal machinery must be protected from catastrophic explosion. For example, CFR states: "There must be a permanent Class A steel bulkhead between any accommodation or machinery space and any compartment containing (explosive) materials. Class 1 materials may not be stowed within 3 meters (10 feet) of this bulkhead." This equates to a potential loss of actual container carrying capacity for ammo, as determined by the stowplan of the vessel. Therefore planners can never be certain that a given ship will be able to handle exactly the amount of ammunition expressed in terms of the perspective ship's TEU rating (32:8).

Ammunition has historically been stowplanned and loaded at a much slower rate than most other types of cargo. For example it normally takes less than three days to load standard cargo aboard ship but four to seven days to load ammunition. Port throughput slows down considerably due to military ammunition port equipment, the frequency of

port calls and the training level of handling personnel. This creates bottlenecks in times of war (25:139).

A drawback of containers is that they are difficult to move ashore without the benefit of a modern port facility (5:2). Most containerized vessels are non-self-sustaining making them dependent on external crane equipment at the port to load and unload. The DoD recognized the potential of containerized movement of ammunition in peacetime, but has harbored the fear that dependence on cranes makes the method vulnerable in wartime if port infrastructure is knocked out. In this case non-self sustaining containerships would be left unable to unload. The Gulf War and Vietnam can be considered exceptional because the applicable gantry cranes were secured and not in danger of being made inoperable. Luckily, commercially useful cranes now exist in most of the world's major ports. Also the DoD possesses 10 crane ships which can be positioned alongside non-self sustaining containerships to facilitate unloading at austere locations (29:15).

There is a major limitation to the DoD use of 20-foot containers to transport it ammunition. The commercial industry has moved beyond this older size to the more efficient 40-foot unit. However, the unusually heavy weight inherent of ammunition precludes their use. A notable improvement to gain access to ships only capable of carrying 40-foot containers was initiated in 1996. It was the use of adapter frames that fit inside a 40-foot cell allowing it to hold two 20-foot containers. These "pontoon" adapters are going to be critical to future operations because the industry standard for ship cells is also now 40' and ships available exclusively with 20-foot cells are becoming

scarcer. The pontoon is an important solution to make DoD ammunition shipping more compatible with industry (28).

### **The Experience of Desert Storm**

The DoD containerized surprisingly little ammunition during Desert Storm. For its part, USTRANCOM tried to promote containerization. The command argued containerization would free up valuable shipping capacity. Container ships are inherently more efficient than older breakbulk vessels. USTRANCOM estimated that six container ships could haul the equivalent of 18 breakbulks. It also stressed that containerized ammunition would speed deployment by capitalizing on the commercial industry's intermodal expertise and capabilities. Furthermore, the command argued it could save money, increase security, and improve in-transit visibility.

USTRANCOM desires met with little success for several reasons. First of all the Army concluded that intra-theater infrastructure lacked the equipment necessary to handle containerized ammunition. In particular, USCENTCOM had a limited field supply point handling capability. The Army feared containerization would actually slow the deployment down. It pointed to "changing priorities" and "the lack of firm requirements" for its' failure to commit to containerized shipments. Unit commanders, supported by General Schwarzkopf, were reluctant to containerize unit equipment because they believed it would split up their precious cargo into hundreds of boxes to be transported on a multitude of ships. As a result, they favored breakbulk over container shipment. Consequently only 2,100 twenty-foot ammunition containers moved from CONUS ports, the vast majority was shipped breakbulk (25:185-186).

The ammunition port at MOTSU, North Carolina, loaded the most cargo (375,892 tons), nearly all of it ammunition, on 38 ships. Those figures represented 22.3 percent of the cargo and 11 percent of the ships loaded in the United States. Due to the wartime volume two other ports loaded ammunition ships. Naval Weapons Station Earle, New Jersey loaded two ships with 11,701 tons, and Concord, California loaded nine ships with 68,361 tons (25:164).

During Desert Storm the efficiencies of containerization were apparent. While container operations went smoothly, problems with breakbulks were obvious. Stevedores at MOTSU took only 68-70 hours to load the *Noble Star* with containerized ammunition compared to an average load time of 8-14 days for breakbulk ammo ships. MSC reported that ship draft limitations at MOTSU prevented MTMC from loading most breakbulk ships to full cube capacity. Military port operators registered safety concerns on ammunition accompanying unit movements whether breakbulk or container. On occasion, pallets of breakbulk ammunition arriving at MOTSU were not blocked and braced. Consequently they had to reload and reconfigure palletized cargo, which slowed down the deployment process. This carelessness also posed unnecessary safety hazards (25:172-185).

### **Post Desert Storm**

USTRANSCOM continued its support and advocacy of DoD containerization following the war. It emphasized containerization during deliberate planning and TPFDD refinement conferences. It championed port and ammunition depot improvements, tried improving container staging, stuffing, and stripping methods and

increased the number of containers in the DoD inventory. Most importantly, the command worked to make the Defense Transportation System (DTS) compatible with the commercial sector's intermodal systems.

Realizing that containerization was "hampered by a steep learning curve," the command pushed the services to use containers and intermodal methods to the maximum extent possible in peacetime so they would feel comfortable using them during war (25:188). USTRANSCOM realized the DoD dependence on commercial shipping for resupply of ammunition. In the early 1990's it started conducting logistics exercises to annually test capabilities for shipping containerized munitions and unit equipment (39:7). These exercises have the prefix TURBO. One series involves the Containerized Ammunition Distribution System (TURBO CADS). In this exercise containerized ammunition is shipped from CONUS depots to OCONUS destinations via the commercial intermodal system. A fully loaded U.S.-flag container capable ship is used to move containerized ammunition from a U.S. strategic ammunition port to an OCONUS port that is determined by a perspective theater CINC. The ship is then reloaded with retrograde ammunition for the trip back to CONUS. This exercise supports the normal rotation of ammunition into and out of theater (29:16).

These exercises have proven valuable in highlighting weaknesses throughout the system. For example, the TURBO CADS 94 after action report concluded that severe shortages of container handling equipment existed throughout the system. These shortages ranged from an inadequate to a total lack of equipment at every node from origin to destination (39:6). TURBO CADS 98 involved a containerized ammunition movement from Port Hadlock, WA to Chinhai Korea. The lessons learned were that

although Port Hadlock could meet its 200 containers per day requirement, and the Chinhae port could not meet its 300 containers per day requirement due to lack of trained crane operators (1).

### **Conclusion**

The shipping container has revolutionized the shipping industry and has had a direct impact on the method used to ship ammunition. The numerous factors involved in containerized ammunition shipping are summarized in Table 3.

**Table 3. Containerized Ammo Shipping Factors (28)**

- Ammunition Port Characteristics (Air & Water Draft)
- International Maritime Dangerous Goods Regulations (IMDG)
- DoD/Coast Guard Packaging, Storage and Transportation Policies
- DoD Packages Ammunition in 20 Foot ISO Containers
- Material Handling Equipment and Loading Throughput
- Port Container Storage Capacity
- The use of pontoon adapters and their availability
- Container Throughput at Load & Discharge Ports
- Ship Size and Capacity
- Ship Structure, Container Hold Layout and Max Stacking Weight
- Port Net Explosive Weight (NEW) Limits

The list above is not all-inclusive but it does point to factors that affect the planning and physical selection of the ships needed to haul sustainment ammunition. The last "benchmark" MTW (Desert Storm) saw only 10% of ammunition requirements shipped by container. This can be contrasted, less than a decade later, with the MRS BURU assumption of at least 80% ammunition containerization, and with the even higher USTRANSCOM goal of 100%.



## V. Ammunition Port Restrictions

**What throughput limitations exist at the three DoD strategic ammunition port facilities as a result of the rise of containerships?**

Ammunition shipped out of the United States, both in peacetime and in war, must pass through one of only three seaports. The three “dedicated” ammunition SPODs are Weapons Support Facility (WSF) Seal Beach, Detachment Port Hadlock, WA, and WSF Seal Beach, Detachment Concord, CA, both on the West Coast. The third is Military Ocean Terminal Sunny Point (MOTSU), NC on the East Coast. The MTMC

### **Strategic Ammunition Ports & Major Depots**

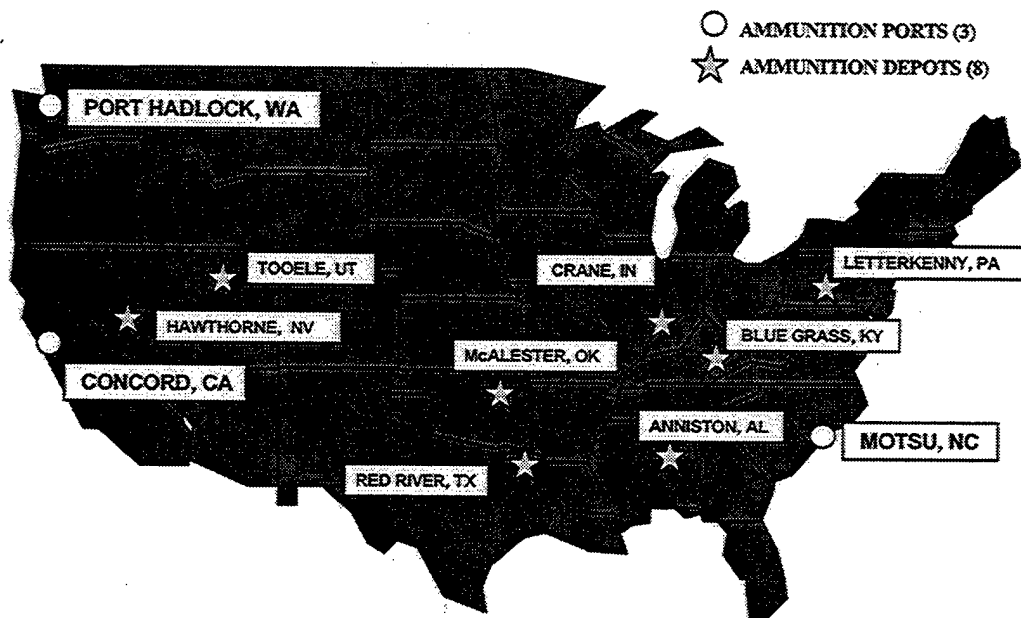


Figure 2. Strategic Ammunition Ports & Major Depots (21)

operated ports are primarily fed ammo in either bulk shipment or containers from eight Tier 1 inland ammunition depot locations operated by the Industrial Operations Command (IOC). Figure 2 shows the location of these specialized ports and depots. Ammunition, in planned wartime required amounts, is not stored at the ports. Rather it is transported from the perspective depots by truck and rail according to the MTMC Surface Distribution Plan (SDP). The SDP is a carefully choreographed sequence of movements based on capabilities, NEW, and asset availability.

The dangerous nature of ammunition limits its trans-loading to these three ports. Unlike civilian cargo that can be marshaled and stockpiled at the dock in large quantities, ammunition has inherent limitations that, by accident or hostile intent, can literally blow up a whole port and its surrounding support complex. This lesson was learned in July 1944 at the port of Concord, CA (called Port Chicago at the time). A handling accident caused an explosion that blew apart two brand new liberty ships. Hundreds of Navy stevedores were killed. The force of the blast sent pieces of the 7,500-ton *E.A. Bryon* and the 10,000-ton *Quinart Victory* eight thousand feet into the air. It leveled buildings three miles inland (9:Sec A, 1). This lesson is the main reason that ammunition is restricted to just the three ports that are relatively remote from large populated areas. It is, therefore, more than likely that these last three ports will be the only dedicated ammunition ports for the next century. With good commercial ports at a premium on both coasts, no community welcomes a facility that handles massive quantities of high explosives. Furthermore, with the size of commercial container ships only growing larger, the specific port limitations of these three sites will only become more critical. Losing port

capability on either coast would add a critical extra 12 days by forcing an inter-ocean passage through the Panama Canal.

Ammunition ports are restricted for the most part by the cumulative NEW allowable. This determines the maximum amount of explosive cargo that may be handled within the port at any one time. The NEW limit of a port determines the maximum number of ships that may be trans-loaded at any given time or it may limit the maximum amount of ammunition that may be loaded onto a single ship. The length of piers and the water depth alongside and through the approaches to a port determine maximum limits for vessel size and factor into maximum cargo capacity. The number of piers, storage and staging areas, rail and road access, and the quality and quantity of cargo handling equipment determine throughput capacity. These limitations affect the size and type of ships that are usable (32:13).

The IOC is the agency responsible for coordinating ammunition shipment. IOC coordinates its loads with MTMC and identifies every type of ammunition by hazard class, NEW, and the weight included in each container. The command designs its loads with ship loading and port restrictions in mind (37). For example, ammunition is not stored in containers at the depot. It must be stuffed at the time of contingency. Therefore careful planning must be done to prevent bottlenecks. Dockside bottlenecks must be avoided also due to NEW limitations of the holding pads. It can be a time consuming process coordinating dissimilar loads, compatible loads, bulkhead clearances, ballast and trim considerations etc. All these factors can stack up and cause potential delays (13).

The rise of the large containership poses multiple physical limitations. The larger the ship, the more difficult it is to access these unique locations. Air and water drafts are

most critical. This is the main reason MSC considers ships that are less than 1,500 TEU as "handy size." Ships larger than this size tend to be either too tall to make it under the bridges, or will reach their water draft limit prior to being fully loaded. WSF Concord for example, is impaired mainly by air and water draft limitations. Figure 3 shows its location well inland of the San Francisco Bay (8). Of note are the last two of the four permanent bridges that large vessels must fit under in order to get into a berth.

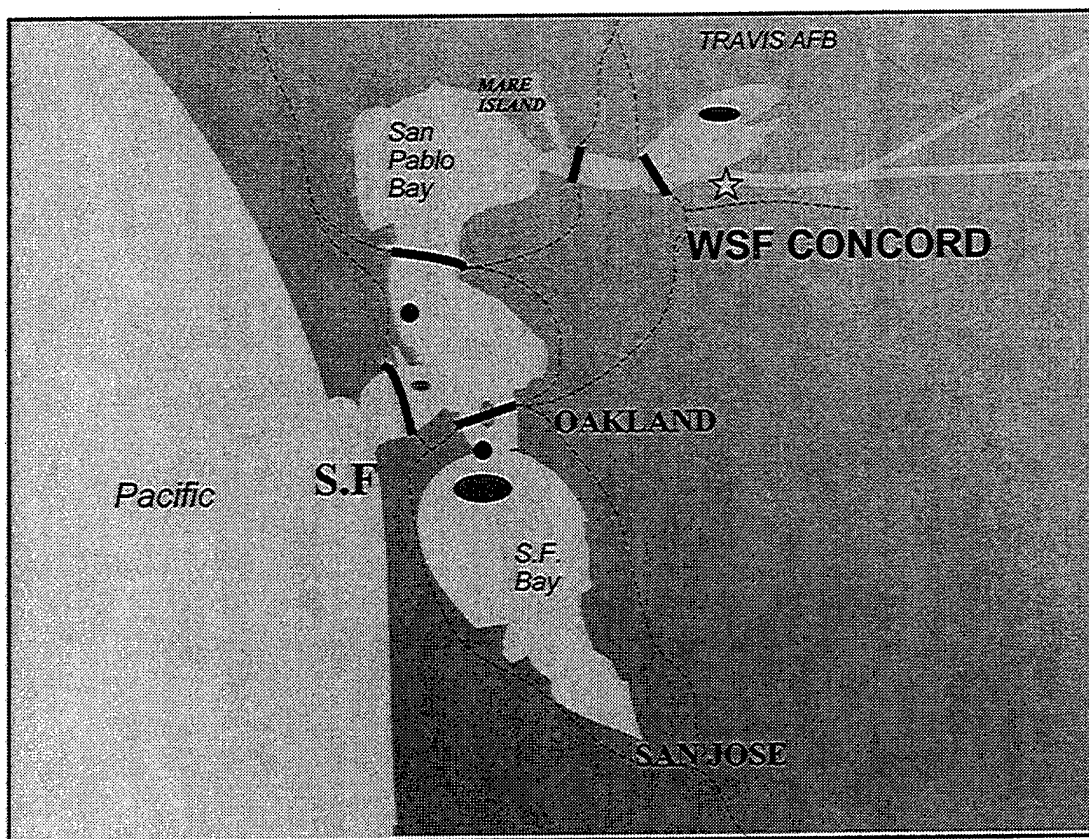


Figure 3. Inland Location of WSF Concord, CA (8)

The channel depth and bridge height on the approach to Concord is depicted in Figure 4. The air draft (A.) is measured at 135 feet, known as the measured higher high water (MHHW). This represents the worst case depth at high river flow and high tide.

Notably, at MHHW, true channel depth is 41 feet not the published 35. MSC uses this figure to accommodate ships with drafts up to 39 feet. The channel depth (B.) of 35 feet is called the measured lower low water (MLLW). This represents the lowest level of combination river flow and low tide. Again of note, air draft is not the published 135 feet but rather 141. These nuances are critical because MSC continuously uses the entire envelope at the bridges to manipulate the limitations of many larger ships which could not otherwise transit to Concord due to either published air or water draft, when

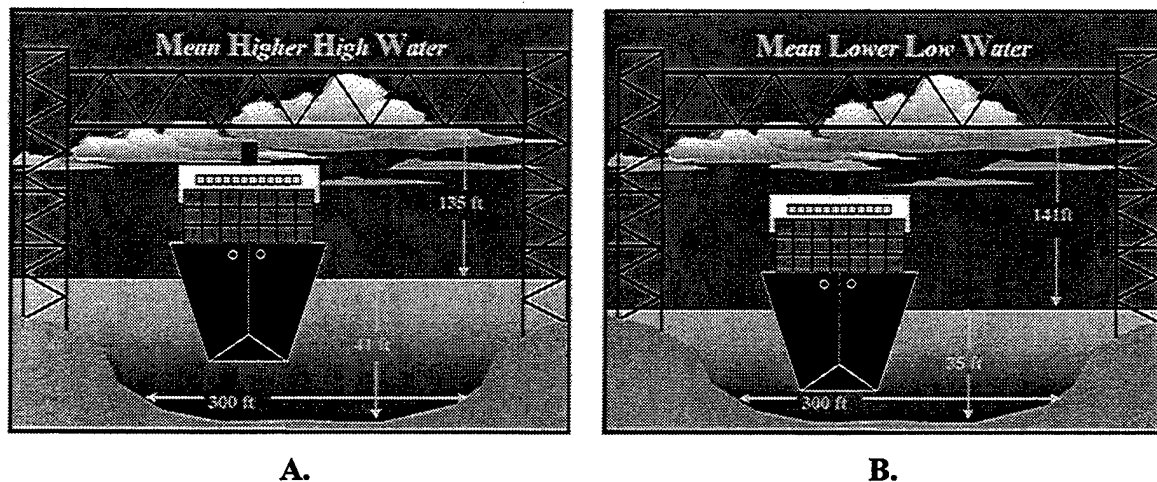


Figure 4. WSF Concord Air and Water Draft Limitations (8)

looked at singularly. MSC and port officials look at the entire equation of tides, masts, trim, ballast, fuel load, etc. to make ship selection decisions (8).

Detailed characteristics of the current overall port limits are shown in Table 4. Note, TEU ship limitations on the chart which may be driven by facility storage space, NEW, intermodal connections, throughput, ship air draft restrictions or alongside water depth. These constraints impact on the ship stowage and loading in a variety of

combinations as shown, and the primary limiting factor is different for each. According to MARAD analysis the most limiting factor for U.S.-flag vessels at each port are:

**Table 4. Strategic Ammunition Port Air and Water Draft Limitations (28)**

	<b>MOTSU</b>	<b>Concord</b>	<b>Port Hadlock</b>
<b>Water Draft</b>	34 feet MLLW 2,500 TEU	35 feet MLLW 2100 TEU	55 feet MLLW
<b>Air Draft</b>	No Restrictions	135 feet MHHW	No Restrictions
<b>Turn Radius</b>	1,000 feet	1,200 feet	Unlimited
<b>NEW</b>	19.2 Million Lbs 3,000 + TEU	11.2 Million Lbs 2,100 TEU	3.25 Million Lbs 880 TEU
<b>Container Berth Length</b>	1,000 feet	1,220 feet	1,600 feet
<b>Ammo Storage Capacity</b>	2,700 TEU	300-600 TEU	Limited by NEW
<b>Rail</b>	Internal & External	Internal & External	Rail/Truck transfer via Bangor, WA
<b>Port Self Sustaining</b>	Yes 2 Gantry Cranes	Completing Gantry	Completing Gantry

**MOTSU:** The loaded draft is constrained to 34 feet at the pier (due to a rock bottom). All 78 U.S.-flag containerships can get into MOTSU but due to draft they are load limited to approximately 2,500 TEU.

**Concord:** The 135-foot air/35-foot water draft limits ship size. Only 63 of 78 U.S.-flag containerships can service Concord but the 15 largest cannot. 10 others require their mast be taken down to allow bridge clearance.

**Port Hadlock:** All 78 U.S.-flag containerships can service the port (27).

## **Conclusion**

MRS BURU assumes port throughput capacity at 10,000 containers per week. However, actual current throughput capacity is estimated by MTMC at no more than 7,000 containers per week. This shortfall is to be eliminated by FY 2001 with ongoing infrastructure improvements. The state of the ports themselves is only one factor in determining throughput. This paper is concerned primarily with the availability of containerships to service these ports. MRS BURU assumes adequate availability of smaller "notional" containerships of approximately 1,500 TEU. This appears to be a correct assumption based on the MARAD analysis of current U.S.-flagged merchant ship accessibility. However, given the static nature of the draft restrictions, the growing size of containerships, especially the trend toward mega-ships, will make port accessibility a certain factor for future contingencies.

## **VI. Ship Allocation Process**

**By what process does Military Sealift Command actually fill the requirement for ammunition sustainment sealift?**

### **The Role of USTRANSCOM**

USTRANSCOM, the DoD's single manager for transportation in both peace and war, is tasked to seek the best mix of transportation capabilities to meet the needs of supported theater war-fighting CINCs. As the joint umbrella command for all DoD movements, it is ultimately responsible for ammunition mode selection and shipment. During an initial wartime surge, USTRANSCOM's Mobility Command Center (MCC) validates the TPFDD and passes sealift requirements to MSC. MSC then determines the "best" method of providing the sealift requested (2). The sustainment process is somewhat different. The various services submit sustainment requisitions based on actual and projected consumption rates. These requisitions are loaded into the future transportation plan and act as sequenced placeholders to be filled by as yet unspecified munitions when the time comes. It is the Industrial Operations Command (IOC) that sources the ammunition and then notifies the Joint Traffic Management Office (JTMO), a division of MTMC, when a full shipload is assembled. JTMO then passes the requirement to MSC (42).

Sealift makes up over 90% of the transportation requirements identified in our current OPLANS and concept plans (CONPLANS). There are five steps to deliberate planning including initiation, concept development, plan development, plan review and supporting plan. At the end of concept development, step 2, the JCS and NCA have approved the CINC's rough outline, or concept of operations for the OPLAN, allowing



detailed planning to begin. Step 3, plan development, includes force planning, support planning, transportation planning, shortfall identification, feasibility analysis. The planners eventually produce a refined TPFDD with details of what, when and how personnel and equipment will move (2). Unlike MRS BURU's notional transportation requirements, OPLANs take into account actual transportation capabilities as they exist at the time of certification. Typically these plans remain on the shelf except for annual refinement. In today's multi-contingency world, we usually do not have the luxury of extended threat warning time to perfect plans so we use a shorter process called Crisis Action Planning.

When a contingency arises, the JCS, NCA, and war-fighting CINC immediately begin assessing the overall situation. In the best case, they can pull a plan off the shelf and call for it to be executed. However, that's not usually the case. There are six phases to crisis action planning: situation development, crisis assessment, course of action development, course of action selection, execution planning, and execution. Sealift is taken into account on a very basic level during course of action development. Courses of action that can't be supported by sealift are never forwarded to the JCS/NCA for consideration. Most of the sealift planning occurs during phase five, execution planning. Physical sealift tasking begins when the NCA/JCS calls for phase six, execution.

Determining which ships get used first depends on the time and unique constraints of each individual ammunition movement. The time element and the amount of ammunition needed dictate the sort of vessel and how soon it can be used. While in a true crisis just about any type of vessel can be used, given enough lead-time, a more selective evaluation of vessels will usually occur (7).

## **The Role of IOC**

The Industrial Operations Command (IOC) is responsible for filling the specific ammunition requirements for all of the DoD. It plans its shipments through a combination of off the shelf requirements documents and constantly updated theater CINC requests. IOC sequences movements of ammunition by tallying them into individual loads and passing on the transportation requirements to JTMO and in turn MSC. This load planning is done with ship and port limitations in mind. Most sustainment capacity is provided for in the war-fighting OPLANs. Shipload batches of ammunition are dispatched to port as fast as possible by truck and rail. Where in peacetime it might take up to six months to build up a full shipload, in a wartime contingency it might take only days (17).

The IOC currently strives for 100% ammunition containerization whenever possible. However, this can be complicated by the fact that many end users/final destinations cannot, or do not want to, handle containerized shipments. Final destination container handling equipment may not be adequate or available (34).

The central player in sustainment ammunition movement is MTMC/JTMO. Its decisions have a great impact on the type of shipping needed due to perspective destination SPOD requirements. For example, unique destination limitations determine if a perspective ship needs to have its' own crane or special ramp equipment. Is there more than one destination that needs to be supplied by a single ship? With ammunition chances are it's a point-to-point haul. A single ship might drop off its ammo at three separate ammunition ports. Multiple services might share a single shipload. These and

other factors must be weighed by MTMC, JTMO and MSC in making its vessel type determination (13).

The actual vessel selection is done by MSC. When it gets its requirements from the IOC and MTMC it sets about to match an available ship. It will try to obtain in order: an open-market commercial vessel, a time-chartered vessel, or, as a last resort, a DoD asset.

### **Commercial Availability**

Choosing individual ships is an imperfect science. Commercial shipping is widely distributed all over the world and is constantly on the move. Availability is unpredictable. Shippers might have less capacity in winter than in the spring or vice-versa due to seasonal traffic patterns. To capture what is available at the given critical time, MSC will first do an informal market survey of U.S. shipping firms. This is done to get a rough idea of capability and generate any immediate bids. MSC might also solicit MARAD for nominations. It will poll various port authorities to get the most up to date ship status information. Usually there will be multiple ships to choose from (13).

But if there are no takers, then a formal request for proposal will be issued to the open market. For a fee, a "ships broker" furnishes MSC with a quarterly survey of all known "militarily useful" vessels worldwide and their availability status (33).

### **Control or Time Charter**

MSC's second choice source is "Controlled Ships." These are ships already under contract for a specific timeframe or "Spot Charters" that are on one time, point-to-

point voyages. These charters are included in the quarterly survey but there is no certainty of availability until the need actually rises (33).

### **Last Resort: DoD Shipping Assets**

As a last resort option MSC will use a DoD shipping asset. This might be a vessel originally involved in initial surge sealift operations. For example, certain types of pre-positioned ships could be re-allocated for ammunition sustainment following their initial surge offloads. Others, such as the 8 FSS and the LMSRs, are primarily large RO/RO vessels normally dedicated for other sustainment track and wheeled cargoes and follow on equipment movement. MSC will only use this category of vessel for sustainment ammunition as a last resort.

Beyond this point CINCTRANS can, with Secretary of Defense approval, activate VISA stage I, II and III as necessary. This decision would have to be weighed against the potential economic dislocation it would cause. The final selection of ships is ultimately based on capability, overall cost to the government, and the mission. Each situation is unique. For example, the choice might simply come down to which vessel is closer to the ammunition port.

### **Conclusion**

Determining which ships get used first depends on the time and unique constraints of each individual ammunition movement. The time element and the amount of ammunition needed will dictate the sort of vessel and how soon it can be used. The actual selection of ships is ultimately based on capability, overall cost to the government, and the required mission.

Vessel nomination is done by MSC. When it gets its requirements from IOC and MTMC/JTMO it sets about to match an available ship. MSC will try to obtain in order: an open-market commercial vessel, a time-chartered vessel, and as a last resort a DoD shipping asset. Beyond this point the activation of VISA stage I, II and III would have to be implemented. This decision would have to be weighed against the potential economic dislocation it would cause.

## **VII. DoD Planning Requirements**

**How accurate are the Mobility Requirement Study-Bottom Up Review (MRS-BURU) requirements for ammunition to support likely scenarios for both one and two near-simultaneous theater wars?**

The Secretary of Defense examined mobility requirements in 1997 as part of the Quadrennial Defense Review (QDR). U.S. capabilities across a continuum of planning scenarios, from smaller-scale contingency operations to MTWs were assessed. The QDR reaffirmed DoD's baseline requirements for inter-theater ammunition sealift as outlined in the 1995 Mobility Requirements Study Bottom-Up Review Update (MRS BURU).

The MRS BURU sustainment ammunition requirements are driven by the need to have the capability to fight and win two near-simultaneous MTWs. It must be understood that at its inception this notional scenario presented the worst case to U.S. planners following the end of the Cold War. Force structure and funding demand realistic/likely threats. MRS BURU envisions a single MTW followed shortly by a second. The scenarios are referred to as West/East and East/West. The transportation resources to swing from West to East are somewhat different from East to West but they are very similar. According to MTMC, transportation requirements are more critical in the first to weeks of the East/West scenario while the West/East is more challenging overall.

### **Scenario**

The MRS BURU war-fighting scenario depicts an attacker stopped in a halting phase prior to achieving essential objectives by the rapid reaction of in-place, pre-positioned and airlifted forces. In order to halt and then counterattack it is essential to

rapidly deploy reinforcing units, equipment and supplies. Over 90% of the heavy equipment and sustainment supplies for these forces must be moved by sea. This concept provides the basis for sizing the strategic mobility force – how much and of what mix of lift is required to deliver the halting forces, reinforcing units, sustainment supplies and the overwhelming force required for decisive offensive action (35).

### **Discussion**

It should be understood that the actual contingency requirements come from sourced OPLAN TPFDD and is therefore constrained by real world capabilities. It is not everything the war-fighting CINC actually wants, but what can be realistically provided and flowed through the depots and seaports at that specific time. An approved OPLAN must be deemed “transportation feasible” which means that the infrastructure and strategic lift is available within the timeframe. On the other hand, the MRS BURU is what the CINCs would actually like to have if they could. Its’ notional TPFDD that puts the “mark on the wall” of what capabilities we should actually have. This is the justification of the millions spent on ammunition depot and seaport improvement projects that improve outload and throughput capacity. It’s an objective measure of our capability from a readiness perspective for use by crisis action planners (20).

Figure 5 provides a comparison view of the difference in the magnitude of ammunition movement between Desert Shield/Desert Storm and the stated MRS BURU requirements. On the right, the dark gray area depicts the Desert Shield/Desert Storm sustainment ammunition movement of nearly 477 tons from 21 CONUS depots to the

three ammunition ports. Although the operation happened only ten years ago, nearly 95% of this ammunition was shipped breakbulk. It required approximately 5500 trucks

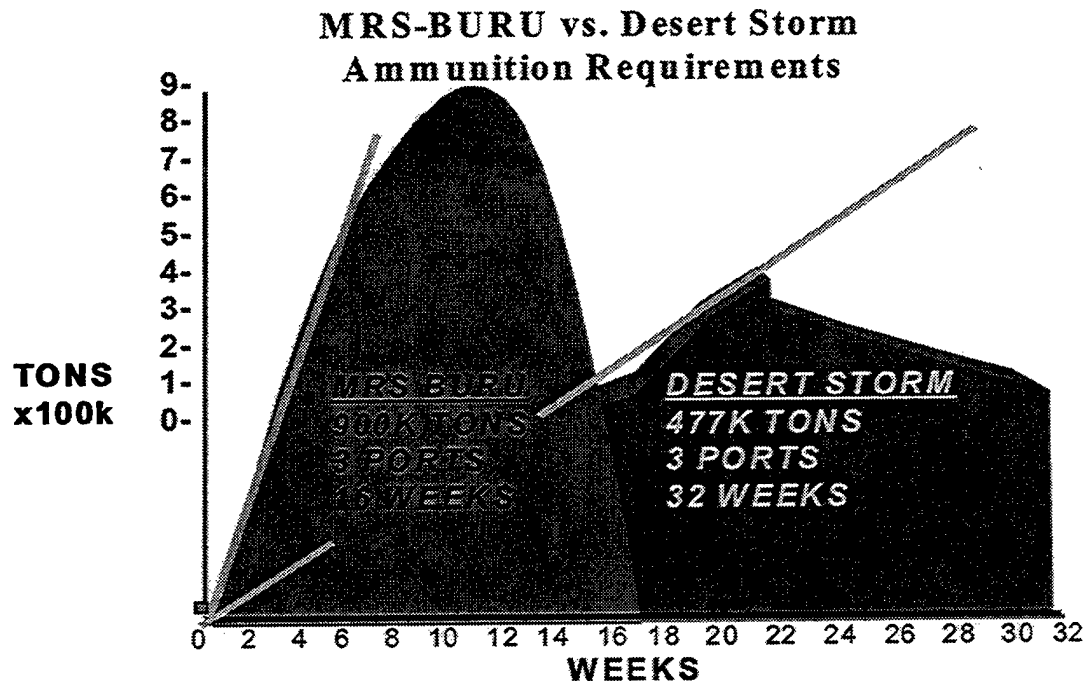


Figure 5. MRS-BURU vs. Desert Storm Ammunition Requirements (21)

and 5,650 railcars. It took a total of 32 weeks to accomplish. On the left, the light gray area represents the MRS-BURU dual MTW requirement. As shown, the goal is to move 900K Tons, from the current eight IOC depots through the three Seaports in only 16 weeks. That's double the Desert Storm requirement in just half the time (21).

It is difficult to determine how much of the requirement is critical. The validity of the amount is in the eye of the war-fighter. No field commander wants to run out of bullets. In the world of military vices having too much ammo is much better than lacking it. However, putting large stocks in harms way before they are needed can result in clogging of the transportation system (18:9).



The tendency for the war-fighter is to be conservative with ammunition estimates and then pad that amount with safety stock. Planners are forced to use estimates derived from previous wars. For Desert Storm, U.S. logistics planners based their tank ammunition consumption estimates on the best previous example--the Second World War. The old data proved excessive as tank crew ammunition consumption fell far short of accepted planning factors. Increased tank accuracy and ammunition lethality produced huge over-estimates. The M-1 Abrams main gun required less than 1.2 rounds for each enemy tank destroyed, contrasted with World War II tank engagements where each main gun averaged 17 rounds per kill (36:81).

Another good example is 155-mm howitzer ammunition. While 3,239,822 rounds arrived in the theater of operations, U.S. forces fired only a fraction. Nearly 3 million rounds returned to the CONUS unused (41:19). Overall the U.S. shipped at least 550,000 tons of ammunition to the Gulf in 1990-1991. A relatively small fraction of that was ever used. Still, we've sized our lift requirements to ship even more to the next MTW (18:10).

Again, what is "enough" ammunition is in the beholding eye of the war-fighter. According to one MTMC official the MRS BURU requirement to move 900,000 tons of ammunition from the CONUS adds up to more than the U.S. even possesses. MRS-BURU provides the dual, near-simultaneous requirement that DOD builds towards. It is what drives strategic mobility enhancement funding. It allows the DoD to work toward a programmatic fix of its transportation limiting factors (20).

Therefore, the main benefit gained from MRS BURU requirements, whether inflated or inadequate, is funding for Defense transportation infrastructure. For example, money is currently being spent to upgrade depot to port ammunition throughput. By

highlighting shortfalls in the required ammunition flow funds for upgrade are being used to increase capacity from the eight ammunition depots to the three primary ammunition seaports. A total of \$113M in strategic mobility funding is being provided to maintain and enhance the seaports to meet the 10,000 containers per week throughput required under MRS BURU by fiscal year 2002 (21).

### **Conclusion**

We base crisis movement on TPFDD OPLANs, but we buy capability based on MRS BURU. The OPLANs that are "on the shelf" are best guess estimates. It should be noted that the two MTW scenarios did not foresee the Balkan crisis as a potential third area for a major conflict. So exactly how much sustainment sealift is "enough"? There is no real answer because "enough" can only be defined in terms of the requirements and capacity on hand at the actual time of crisis planning/execution. According to planners at MSC and MTMC no serious sustainment sealift shortfall exists at this time to meet the actual requirements for the two MTW scenario based on current OPLANs. However, in strictly MRS BURU terms, there will be a shortfall in throughput capacity until fiscal 2002.

## **VIII. Conclusion**

### **Research Question Overview**

This research paper examines current DoD and commercial sealift infrastructure to explore its ability to provide for all of the stated ammunition sustainment requirements. A background overview of U.S. strategic sealift was given in Chapter II. It summarized how current DoD and commercial sealift infrastructure reached its current state. Chapters III through VII addressed specific supporting questions. The questions are restated in sequence 1 to 5 and are followed with research findings for each:

#### **1. What is the impact of the growth in containership size?**

Many problems are in the eye of the beholder. With the foreseeable trend in ship size only climbing, the MRS BURU assumption of a notional container ship as 1,500 TEU may not be realistic. The newer the ship, the less 20' capacity it probably has. The good news is the use of adapter frames should make any containership useful, at least to some extent, for carrying ammunition. The bad news is that the size of the ship itself, not its configuration, might be the biggest limiting factor preventing it from being usable.

#### **2. How has the Army's ammunition containerization effort affected shipping?**

The shipping container has revolutionized the shipping industry and has had a direct impact on the method used to ship ammunition. The numerous factors involved in containerized ammunition shipping are summarized in Table 5. The list is not all-

inclusive but it does point to factors that affect the planning and physical selection of the ships needed to haul sustainment ammunition.

**Table 5. Containerized Ammo Shipping Factors (28)**

- Ammunition Port Characteristics (Air & Water Draft)
- International Maritime Dangerous Goods Regulations (IMDG)
- DoD/Coast Guard Packaging, Storage and Transportation Policies
- DoD Packages Ammunition in 20 Foot ISO Containers
- Material Handling Equipment and Loading Throughput
- Port Container Storage Capacity
- The use of pontoon adapters and their availability
- Container Throughput at Load & Discharge Ports
- Ship Size and Capacity
- Ship Structure, Container Hold Layout and Max Stacking Weight
- Port Net Explosive Weight (NEW) Limits

The last "benchmark" MTW (Desert Storm) saw only 10% of ammunition requirements shipped by container. This can be contrasted, less than a decade later, with the MRS BURU assumption of at least 80% ammunition containerization, and with the even higher USTRANSCOM goal of 100%.

**3. What throughput limitations exist at the three DoD strategic ammunition port facilities as a result of the rise of containerships?**

MRS BURU assumes port throughput capacity at 10,000 containers per week. However, actual current throughput capacity is estimated by MTMC at no more than 7,000 containers per week. This shortfall is to be eliminated by FY 2001 with ongoing infrastructure improvements. The state of the ports themselves is only one factor in determining throughput. This paper is concerned primarily with the availability of containerships to service these ports. MRS BURU assumes adequate availability of

smaller "notional" containerships of approximately 1,500 TEU. This appears to be a correct assumption based on the MARAD analysis of current U.S.-flagged merchant ship accessibility. However, given the permanent nature of the draft restrictions, the growing size of containerships--especially the trend toward mega-ships--port accessibility will be a certain factor for future contingencies.

**4. By what process does Military Sealift Command actually fill the requirement for ammunition sustainment sealift?**

Determining which ships get used first depends on the time and unique constraints of each individual ammunition movement. The time element and the amount of ammunition needed will dictate the sort of vessel and how soon it can be used. The actual selection of ships is ultimately based on capability, overall cost to the government, and the required mission.

Vessel nomination is done by MSC. When it gets its requirements from the IOC and MTMC it sets about to match an available ship. MSC will try to obtain in order: an open-market commercial vessel, a time-chartered vessel, and as a last resort a DoD shipping asset. Beyond this point the activation of VISA stage I, II and III would have to be implemented. This decision would have to be weighed against the potential economic dislocation it would cause.

**5. How accurate are the MRS-BURU requirements for ammunition to support likely scenarios for both one and two near-simultaneous theater wars?**

We base crisis movement on TPFDD OPLANs, but we buy capability based on MRS BURU. The OPLANs that are "on the shelf" are best guess estimates. It should be noted that the two MTW scenario did not foresee the Balkan crisis as a potential third area for a major conflict. So exactly how much sustainment sealift is "enough"? There is no real answer because "enough" can only be defined in terms of the requirements and capacity on hand at the actual time of crisis planning/execution. According to planners at MSC and MTMC no serious shortfall exists at this time to meet the actual requirements for the two MTW scenario based on current OPLANs. However, in strictly MRS BURU terms, there will be a shortfall in throughput capacity until fiscal 2002.

**Overall Conclusion**

The current planned DoD wartime ammunition sustainment requirements are very large. Ammunition itself is a unique and dangerous cargo that is currently limited to loading and unloading at only three U.S. strategic ammunition ports. The availability of container ships of the proper size and configuration is dependent on conditions at the actual time of execution. It also depends on the current geographical location of perspective vessels at that moment.

The limitations of available of ocean shipping of the correct size and capability must be understood by logistics planners and USTRANSCOM in order to make efficient decisions on ammunition movement and method of shipping. Flow must be planned accurately from fort to port, at the dock area (not to exceed maximum allowable

explosive tonnage at dock location while loading), and from port to forward operating theater.

Current acquisitions and partnering arrangements allow military planners to tailor this fleet to meet known threats against U.S. national security through the deliberate planning process and the planning programming and budgeting system (PPBS-not discussed in this paper). While a strong merchant maritime fleet is beneficial to the national economy, it is critical for national defense. In times of war, the U.S. must have access to commercial ships. The Merchant Marine Act of 1930 addressed the U.S. maritime industry but did not sufficiently address the economics required to implement a viable long-term solution. The most agreeable solution to date in order to ensure access to commercial vessels (other than requisitioning or nationalizing commercial ships) is undoubtedly the VISA program. While VISA may incur slightly higher shipping fees, it provides the peacetime volume to commercial shippers necessary to maintain the properly sized wartime fleet as determined by MARAD.

The template for a major contingency ammunition movement remains Desert Shield/Storm. However, U.S. commercial fleet and standard container technologies have changed since 1990. Virtually all of the U.S. war-fighter's sustainment ammunition has been transported by breakbulk and 20 foot capable container ships. But in 1999 these ships are being phased out of the commercial inventory in favor of larger container vessels. This research paper addressed current and short-term capabilities versus stated requirements in an attempt to identify potential shortfalls.

## APPENDIX A: List Of Acronyms

Ammo	Ammunition
AOR	Area of Responsibility
APF	Afloat Pre-positioning Force
Breakbulk	Non-Containerized dry cargo vessel
CADS	Containerized Ammunition Distribution System
CENTCOM	Central Command
CONPLAN	Concept Plan
CONUS	Continental United States
CRF	Code of Federal Regulation
DoD	Department of Defense
DOS	Days of Supply
DoT	Department of Transportation
DTS	Defense Transportation System
DWT	Deadweight Tons
FSS	Fast Sealift Ship
IMDG	International Maritime Dangerous Goods
IOC	Industrial Operations Command
ISO	International Standards Organization
JTMO	Joint Traffic Management Office
LMSR	Large Medium Speed RORO vessel
MARAD	Maritime Administration (Agency of DoT)
Mega-Ship	Large Containership (Usually 4000 TEU or greater)
MHE	Material Handling Equipment
MHHW	Measured Higher High Water
MLLW	Measured Lower Low Water
MOTSU	Military Ocean Terminal Sunny Point
MRS	Mobility Requirement Study
MRS BURU	Mobility Requirement Study Bottom Up Review
MSC	Military Sealift Command
MTMC	Military Traffic Management Command
MTW	Major Theater War
NCA	National Command Authorities
NEW	Net Explosive Weight



NDRF	National Defense Reserve Fleet
OCONUS	Outside the Continental United States
OPLAN	Operational Plan
Pontoon	Adapter frames that fit inside a 40' cell allowing it to hold two 20' containers
RFP	Request For Proposal
RO/RO	Roll on roll off ship ideal for carrying vehicles
RRF	Ready Reserve Fleet
SECDEF	Secretary of Defense
SPOD	Sea Port of Debarkation
SPOE	Sea Port of Embarkation
SRP	Sealift Readiness Program
TEU	Twenty-foot Equivalent Unit
TPFDD	Time Phased Force Deployment Data
TURBO CADS	Containerized Ammunition Distribution System Exercise sponsored by USTRANSCOM
TWCF	Transportation Working Capital Fund
USCENTCOM	United States Central Command
USTRANSCOM	United States Transportation Command
VISA	Volunteer Intermodal Sealift Agreement

## Bibliography

1. Adams, Gary H. Chief Intermodal Team (TCJ4-LTI). "Joint Container Exercise Program 98." Slide Presentation, United States Transportation Command, Scott AFB IL, 1998.
2. Air Mobility Warfare Center. Lecture to Air Mobility Operations Course. Air Mobility Warfare Center, Fort Dix NJ, June 1998.
3. Ballantine, Duncan S. U.S. Naval Logistics in the Second World War. Princeton NJ: Princeton University Press, 1947.
4. Bates, Basil B. U.S. Strategic Sealift Capability in 1994: Is it ready for the Threat? MS thesis, Naval War College, Newport RI, February 1994 (AD-B184498).
5. Beary, William J. Jr. Expeditionary Ship-To-Shore Logistics: Can We Get There From Here? Research paper, Naval War College, Newport RI , 13 June 1997.
6. Bonney, Joseph. "Night and Day at Lykes," American Shipper, 40: 78-82 (April 1998).
7. Bouchard, Robert. Transportation Specialist, Intermodal Transportation Office, Maritime Administration, Washington DC. Telephone interview. 9 February 1999.
8. Bruno, Captain, USN Paul N. "Concord Naval Weapons Station," Slide Presentation. Weapons Support Facility Seal Beach, Detachment Concord, Concord CA, 1998.
9. Davies, Lawrence. "At Least 350 Dead as Munitions Ships Blow Up on Coast," The New York Times, 19 July 1944, sec A:1.
10. DefenseLINK News. "Secretary Of Defense Approves Voluntary Sealift Agreement." Excerpt from website, n. pag. <http://www.defenselink.mil/news.htm>. 4 February 1997.
11. Department of the Navy. "Navy Doctrine." Chapter 2. <http://ndcweb.navy.mil/Ndp1/ndp10003.htm>. 17 March 99.
12. Ensminger, Captain, USN D.S. Letter to the National Security Decision Making Department, U.S. Naval War College, Newport RI, December 1993.

13. Grace, Al. Dry Cargo Project Officer, Military Sealift Command, Washington DC. Telephone interview. 11 February 1999.
14. Graykowski, John E. "Filling the Critical Need for Sealift," Sea Power, 40: 19 (September 1997).
15. Herberger, Vice Admiral (Ret), USN Albert J. "Fulfilling a Strategic Maritime Imperative," Defense Transportation Journal, 48: 8 (April 1997).
16. Hume, John G. Military Sealift Command, Washington DC. Telephone interview. 11 February 1999.
17. Jones, Mike. Chief of Transportation Operations, Industrial Operations Command, Rock Island IL. Telephone interview. 8 February 1999.
18. Kassing, David. "The Logistics System After Next," Paper prepared for The Conference on Innovation and Naval Technology 2020. 17 December 1995.
19. Kross, General, USAF Walter. Commander in Chief, U.S. Transportation Command, U.S. Transportation Command Posture. Statement to 105<sup>th</sup> Congress, Washington DC, 1997.
20. Lehman, Major, USA Robert J. Plans Officer, Military Traffic Management Command, Falls Church VA. Personal interview. 10 November 1998.
21. ----. "Munitions Carrier Readiness Program," Slide Presentation. Military Traffic Management Command, Falls Church VA. 10 November 1998.
22. Mahan, Alfred T. The Influence of Sea Power upon History 1660-1805. Englewood Cliffs, NJ: Prentice Hall, 1980.
23. Maritime Security Act, Meeting National Sealift Needs. Information Brochure. Washington DC: Maritime Administration, August 1998.
24. Mathews, James K. The National Defense Reserve Fleet and the Ready Reserve Force, A Chronology. Scott AFB IL: U.S. Transportation Command Research Center, 1997.
25. Mathews, James K. So Many, So Much, So Far, So Fast. Washington DC: U.S. Government Printing Office, 1998.
26. Matter, Lieutenant Colonel, USMC. "Getting to the Fight...Mobility Concepts Programs." Briefing, U.S. Transportation Command, Scott AFB IL, June 1998.

27. McMahan, Jeffery. Chief Sealift Programs Division, Maritime Administration, Washington DC. Personal Interview. 10 November 1998.
28. -----, "Container Ordnance Loading Analysis," Slide Presentation, Maritime Administration, Washington DC, 8 November 1998.
29. Melvin, Albert A. "The U.S. Flag Merchant Marine's Containership Fleet: The Key to U.S. Strategic Sealift," Defense Transportation Journal, 52: 10-16 (April 1996).
30. Military Sealift Command. Excerpt from website, n pag. <http://www.msc.navy.mil/N00p/orgstr.htm>. 3 August 1998.
31. Military Traffic Management Command. TURBO INTERMODAL SURGE (TIS) 96. After Actions Report. Falls Church VA: September 1996.
32. Nashold, Andrea G. Military Sealift Command Decision Aid for Assigning Shipping Assets to Ammunition Cargo. MS thesis, Naval Postgraduate School, Monterey CA, September 1991 (AD-B161504).
33. Noel, Janet. Dry Cargo Project Office, Military Sealift Command, Washington DC. Telephone interview. 11 February 1999.
34. Rice, Rita. Traffic Management Specialist, Industrial Operations Command, Rock Island IL. Telephone interview. 8 February 1999.
35. Rutherford, General, USAF Robert L., Commander in Chief, U.S. Transportation Command, "Working Together for Defense Transportation System 2010." Prepared Statement to the Senate Armed Services Committee, Washington DC, 23 February 1995.
36. Scales, Robert H. Certain Victory: The U.S. Army in the Gulf War. Office of the Chief of Staff, U.S. Army, Washington DC, 1993.
37. Shaw, Gary. Transportation Director, Industrial Operations Command, Rock Island IL. Telephone interview. 8 February 1999.
38. Sinclair, Joseph. Arteries of War: The History of Military Transportation. Shrewsbury UK: Airlife Publishing Ltd., 1992.
39. United States Transportation Command, Containerized Munitions Exercise (TURBO CADS) 94. After Actions Report. Scott AFB IL, 1994.
40. Voluntary Intermodal Sealift Agreement (VISA). Information Brochure. Washington DC: Maritime Administration, July 1998.

41. Wakefield, Lieutenant General, USA Sam. "Directions for a New Era," Defense Transportation Journal, 48: 19 (December 1992).
42. Walker, Commander, USN Lou. Intermodal Logistics Team (TCJ4-LTI), U.S. Transportation Command, Scott AFB IL. Personal Interview. 10 November 1998.

## Vita

Major Paul R. Murphy was born on 11 December 1963 in Boston, Massachusetts. After graduating from Boston Latin School in 1982, he attended Northeastern University and received a Bachelor of Science degree in Computer Science. He received a Master of Science degree in Aeronautical Science from Embry-Riddle University of Daytona, Florida in 1996. He was commissioned on 30 June 1987 through the Air Force Reserve Officer Training Corps at Boston University.

He completed undergraduate pilot training in 1989 and was assigned to Plattsburgh AFB, New York. While at Plattsburgh, he held positions as a Standardization and Evaluation Copilot, Aircraft Commander, and Assistant Flight Commander. In 1994 he was transferred to McConnell AFB, Kansas. There he was assigned to wing scheduling branch and then upgraded to instructor and evaluator pilot. As squadron Chief of Mobility he led deployment efforts in numerous real world deployments and an AMC/IG Operational Readiness Inspection. In 1996 he was placed in charge of initial cadre, lead squadron, developing the PACER CRAG avionics upgrade to the KC-135. Following contract go-ahead, he became 22<sup>nd</sup> Operations Group executive officer.

In June 1998, he entered the Advanced Study of Air Mobility program at the Air Mobility Warfare Center, Fort Dix, New Jersey, sponsored by Air Mobility Command and the Air Force Institute of Technology. He has accumulated 2,800 flying hours and has flown airlift and air refueling missions in support of multiple operations including Desert Shield/Desert Storm.

Permanent Address: 137 Dana Ave  
Boston MA 02136

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